

REPRODUCIBLE SELECTION OF MEMBERS IN A HIERARCHY

TECHNICAL FIELD OF THE INVENTION

This invention relates to the field of data selection and manipulation, and more particularly to reproducible selection of members in a hierarchy.

BACKGROUND OF THE INVENTION

- It is often desirable within a business or other planning environment to generate and/or analyze information regarding sales, demand, supply, selling price, or other data concerning a product or other item. Data for products may often be dependent in some manner on data for other hierarchically related products. For example, sales of products in a particular geographic region may be reflect sales for the products in a particular territory in the region. Because of these hierarchical dependencies, the data concerning various products or other items may be stored hierarchically in data storage or derived in a hierarchical fashion. Furthermore, the data may be stored at a storage location associated with multiple dimensions, such as a product dimension (the storage location being associated with a particular product or product component), a geography dimension (the storage location being associated with a particular geographical area), and a time dimension (the storage location being associated with a particular time or time period).
- It is often desirable to select a subset of the members of a hierarchical dimension for use in a particular process (for example, to view planning data associated with particular products). The hierarchical dimensions reflect real world structures in the organization and these structures can change on a frequent basis. When members of a hierarchical dimension are added or deleted, have their position in the hierarchy changed, or have other characteristics changed on a frequent basis, a "hard coded" set of members used to perform a particular business process or function may quickly become out of date and have to be recreated. This process is time-consuming and inefficient and hampers the planning or other functions of a business.

SUMMARY OF THE INVENTION

According to the present invention, disadvantages and problems associated with previous hierarchical member selection techniques have been substantially reduced or eliminated.

5 According to one embodiment of the present invention, a method for selecting members in a hierarchy includes determining a sequence of one or more actions associated with a member selection tree. The actions collectively selecting one or more members from a hierarchy of members. The hierarchy of members is associated with a particular dimension of an organization of data. The method further includes
10 recording the sequence of actions in a member selection script. In addition, the method includes executing the member selection script to select one or more members after the hierarchy of members has been modified.

Embodiments of the present invention may provide one or more technical advantages. For example, particular embodiments include a system that allows a user
15 to select members from a hierarchical dimension and that can then reproduce a selection of members that meets the same end purpose as the user's selection after the hierarchy members or their relationships change. Such embodiments allow the steps of a user-defined workflow created through a user interface to be quickly defined in a generic and reusable manner. Rather than remembering the members that are
20 selected, such a system remembers the sequence of events the user went through to determine the members that were selected. This sequence of events can then be repeated once the hierarchy is modified and produce a new selection of members that satisfies the user's original intent.

The effective life of such member selection processes may be a significant
25 length of time, spanning many cycles of changes or reorganizations of the underlying hierarchical dimension. This significantly reduces the effort necessary to support a planning or other process that uses the selected members as input and also helps to ensure that the selection continues to be the members that satisfy the original intent of the user, even where there may be changed circumstances (including those of which
30 the user is unaware). Without such a system, the user may have to constantly recreate the member selections (thus wasting time that would be better employed in the

business process) or risk that the wrong information will be used in the process due to the selection not being up to date.

Other important technical advantages are readily apparent to those skilled in the art from the figures, descriptions, and claims included herein.

11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
525
526
527
528
529
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
741
742
743
744
745
746
747
748
749
750
751
752
753
754
755
756
757
758
759
760
761
762
763
764
765
766
767
768
769
770
771
772
773
774
775
776
777
778
779
780
781
782
783
784
785
786
787
788
789
790
791
792
793
794
795
796
797
798
799
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824
825
826
827
828
829
830
831
832
833
834
835
836
837
838
839
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
860
861
862
863
864
865
866
867
868
869
870
871
872
873
874
875
876
877
878
879
880
881
882
883
884
885
886
887
888
889
890
891
892
893
894
895
896
897
898
899
900
901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
940
941
942
943
944
945
946
947
948
949
950
951
952
953
954
955
956
957
958
959
960
961
962
963
964
965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
980
981
982
983
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
1000
1001
1002
1003
1004
1005
1006
1007
1008
1009
1010
1011
1012
1013
1014
1015
1016
1017
1018
1019
1020
1021
1022
1023
1024
1025
1026
1027
1028
1029
1030
1031
1032
1033
1034
1035
1036
1037
1038
1039
1040
1041
1042
1043
1044
1045
1046
1047
1048
1049
1050
1051
1052
1053
1054
1055
1056
1057
1058
1059
1060
1061
1062
1063
1064
1065
1066
1067
1068
1069
1070
1071
1072
1073
1074
1075
1076
1077
1078
1079
1080
1081
1082
1083
1084
1085
1086
1087
1088
1089
1090
1091
1092
1093
1094
1095
1096
1097
1098
1099
1100
1101
1102
1103
1104
1105
1106
1107
1108
1109
1110
1111
1112
1113
1114
1115
1116
1117
1118
1119
1120
1121
1122
1123
1124
1125
1126
1127
1128
1129
1130
1131
1132
1133
1134
1135
1136
1137
1138
1139
1140
1141
1142
1143
1144
1145
1146
1147
1148
1149
1150
1151
1152
1153
1154
1155
1156
1157
1158
1159
1160
1161
1162
1163
1164
1165
1166
1167
1168
1169
1170
1171
1172
1173
1174
1175
1176
1177
1178
1179
1180
1181
1182
1183
1184
1185
1186
1187
1188
1189
1190
1191
1192
1193
1194
1195
1196
1197
1198
1199
1200
1201
1202
1203
1204
1205
1206
1207
1208
1209
1210
1211
1212
1213
1214
1215
1216
1217
1218
1219
1220
1221
1222
1223
1224
1225
1226
1227
1228
1229
1230
1231
1232
1233
1234
1235
1236
1237
1238
1239
1240
1241
1242
1243
1244
1245
1246
1247
1248
1249
1250
1251
1252
1253
1254
1255
1256
1257
1258
1259
1260
1261
1262
1263
1264
1265
1266
1267
1268
1269
1270
1271
1272
1273
1274
1275
1276
1277
1278
1279
1280
1281
1282
1283
1284
1285
1286
1287
1288
1289
1290
1291
1292
1293
1294
1295
1296
1297
1298
1299
1300
1301
1302
1303
1304
1305
1306
1307
1308
1309
1310
1311
1312
1313
1314
1315
1316
1317
1318
1319
1320
1321
1322
1323
1324
1325
1326
1327
1328
1329
1330
1331
1332
1333
1334
1335
1336
1337
1338
1339
1340
1341
1342
1343
1344
1345
1346
1347
1348
1349
1350
1351
1352
1353
1354
1355
1356
1357
1358
1359
1360
1361
1362
1363
1364
1365
1366
1367
1368
1369
1370
1371
1372
1373
1374
1375
1376
1377
1378
1379
1380
1381
1382
1383
1384
1385
1386
1387
1388
1389
1390
1391
1392
1393
1394
1395
1396
1397
1398
1399
1400
1401
1402
1403
1404
1405
1406
1407
1408
1409
1410
1411
1412
1413
1414
1415
1416
1417
1418
1419
1420
1421
1422
1423
1424
1425
1426
1427
1428
1429
1430
1431
1432
1433
1434
1435
1436
1437
1438
1439
1440
1441
1442
1443
1444
1445
1446
1447
1448
1449
1450
1451
1452
1453
1454
1455
1456
1457
1458
1459
1460
1461
1462
1463
1464
1465
1466
1467
1468
1469
1470
1471
1472
1473
1474
1475
1476
1477
1478
1479
1480
1481
1482
1483
1484
1485
1486
1487
1488
1489
1490
1491
1492
1493
1494
1495
1496
1497
1498
1499
1500
1501
1502
1503
1504
1505
1506
1507
1508
1509
1510
1511
1512
1513
1514
1515
1516
1517
1518
1519
1520
1521
1522
1523
1524
1525
1526
1527
1528
1529
1530
1531
1532
1533
1534
1535
1536
1537
1538
1539
1540
1541
1542
1543
1544
1545
1546
1547
1548
1549
1550
1551
1552
1553
1554
1555
1556
1557
1558
1559
1560
1561
1562
1563
1564
1565
1566
1567
1568
1569
1570
1571
1572
1573
1574
1575
1576
1577
1578
1579
1580
1581
1582
1583
1584
1585
1586
1587
1588
1589
1590
1591
1592
1593
1594
1595
1596
1597
1598
1599
1600
1601
1602
1603
1604
1605
1606
1607
1608
1609
1610
1611
1612
1613
1614
1615
1616
1617
1618
1619
1620
1621
1622
1623
1624
1625
1626
1627
1628
1629
1630
1631
1632
1633
1634
1635
1636
1637
1638
1639
1640
1641
1642
1643
1644
1645
1646
1647
1648
1649
1650
1651
1652
1653
1654
1655
1656
1657
1658
1659
1660
1661
1662
1663
1664
1665
1666
1667
1668
1669
1670
1671
1672
1673
1674
1675
1676
1677
1678
1679
1680
1681
1682
1683
1684
1685
1686
1687
1688
1689
1690
1691
1692
1693
1694
1695
1696
1697
1698
1699
1700
1701
1702
1703
1704
1705
1706
1707
1708
1709
1710
1711
1712
1713
1714
1715
1716
1717
1718
1719
1720
1721
1722
1723
1724
1725
1726
1727
1728
1729
1730
1731
1732
1733
1734
1735
1736
1737
1738
1739
1740
1741
1742
1743
1744
1745
1746
1747
1748
1749
1750
1751
1752
1753
1754
1755
1756
1757
1758
1759
1760
1761
1762
1763
1764
1765
1766
1767
1768
1769
1770
1771
1772
1773
1774
1775
1776
1777
1778
1779
1780
1781
1782
1783
1784
1785
1786
1787
1788
1789
1790
1791
1792
1793
1794
1795
1796
1797
1798
1799
1800
1801
1802
1803
1804
1805
1806
1807
1808
1809
1810
1811
1812
1813
1814
1815
1816
1817
1818
1819
1820
1821
1822
1823
1824
1825
1826
1827
1828
1829
1830
1831
1832
1833
1834
1835
1836
1837
1838
1839
1840
1841
1842
1843
1844
1845
1846
1847
1848
1849
1850
1851
1852
1853
1854
1855
1856
1857
1858
1859
1860
1861
1862
1863
1864
1865
1866
1867
1868
1869
1870
1871
1872
1873
1874
1875
1876
1877
1878
1879
1880
1881
1882
1883
1884
1885
1886
1887
1888
1889
1890
1891
1892
1893
1894
1895
1896
1897
1898
1899
1900
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
2042
2043
2044
2045
2046
2047
2048
2049
2050
2051
2052
2053
2054
2055
2056
2057
2058
2059
2060
2061
2062
2063
2064
2065
2066
2067
2068
2069
2070
2071
2072
2073
2074
2075
2076
2077
2078
2079
2080
2081
2082
2083
2084
2085
2086
2087
2088
2089
2090
2091
2092
2093
2094
2095
2096
2097
2098
2099
2100
2101
2102
2103
2104
2105
2106
2107
2108
2109
2110
2111
2112
2113
2114
2115
2116
2117
2118
2119
2120
2121
2122
2123
2124
2125
2126
2127
2128
2129
2130
2131
2132
2133
2134
2135
2136
2137
2138
2139
2140
2141
2142
2143
2144
2145
2146
2147
2148
2149
2150
2151
2152
2153
2154
2155
2156
2157
2158
2159
2160
2161
2162
2163
2164
2165
2166
2167
2168
2169
2170
2171
2172
2173
2174
2175
2176
2177
2178
2179
2180
2181
2182
2183
2184
2185
2186
2187
2188
2189
2190
2191
2192
2193
2194
2195
2196
2197
2198
2199
2200
2201
2202
2203
2204
2205
2206
2207
2208
2209
2210

BRIEF DESCRIPTION OF THE DRAWINGS

To provide a more complete understanding of the present invention and the features and advantages thereof, reference is made to the following description taken in conjunction with the accompanying drawings, in which:

5 FIGURE 1 illustrates an example system for storing and using a hierarchical organization of data;

FIGURE 2 illustrates an example product dimension within a multi-dimensional organization of data;

10 FIGURE 3 illustrates an example geography dimension within a multi-dimensional organization of data;

FIGURE 4 illustrates an example member selection interface;

FIGURE 5 illustrates an example hierarchy upon which a member selection script may operate; and

15 FIGURE 6 illustrates an example method for creating and reproducing member selections.

DESCRIPTION OF EXAMPLE EMBODIMENTS

FIGURE 1 illustrates an example system 10 for storing and using a hierarchical organization of data associated with a business or other planning environment. As described below, system 10 may be used to access and store values associated with particular data members in a data storage device or in a representation of data. As examples only, these values may include actual sales, forecasted sales, actual demand, forecasted demand, available supply, selling price, or any other quantifiable data measure associated with a particular product or other item. Furthermore, although products are typically referred to herein, system 10 may be used to store and access data for appropriate tangible or non-tangible items other than products, including but not limited to services or other benefits.

Example system 10 includes a server 12, a client 14, and data storage 16. Server 12 may include one or more processes to receive administration, analysis, and planning input from client 14 and interact with data storage 16 to provide corresponding output to client 14. These processes may be separate processes running on a dedicated processor or these processes may be integrated, in whole or in part, and run on one or more processors within the same or different computers. Similarly, client 14 may include one or more processes that provide appropriate data administration, analysis, and planning input. These processes may be separate processes running on a dedicated processor or these processes may be integrated, in whole or in part, and run on one or more processors within the same or different computers. Client 14 and server 12 may be fully autonomous or may operate at least in part subject to input from users of system 10. Furthermore, although system 10 is described as including client 14 and server 12, any other appropriate components for storing, accessing, managing, manipulating, or otherwise using hierarchical data associated with data storage 16 may also or alternatively be included in system 10.

The term "data storage" is used to refer to any appropriate data source, representation of data, or other organization of data. Data storage 16 may be hierarchical in nature, may be multi-dimensional, and/or may provide persistent data storage for system 10. For example, data storage 16 may be a multi-dimensional database that stores data in a hierarchical and multidimensional format or data storage 16 may be a representation of data derived by server 12 or other appropriate

component from data stored in a relational database, in memory, or in any other appropriate location. In one embodiment, data storage 16 includes three-dimensional data and, for each data measure, associates with each storage location 18 a particular member from the product dimension, a particular member from the geography dimension, and a particular member from the time dimension. Each of these particular combinations of members of these three dimensions is associated with a corresponding storage location 18 in data storage 16, similar to each combination of coordinates from the x, y, and z axes being associated with a point in three-dimensional Euclidian space. Furthermore, position within a particular dimension may be changed independent of members of other dimensions, much like the position of a coordinate along the x axis may be changed independent of the positions of other coordinates along the y and z axes in three-dimensional Euclidian space.

Data storage 16 may have as few or as many dimensions as appropriate for the particular application. For example, and not by way of limitation, an enterprise associated with system 10 may not consider geography in connection with its data usage. This might be the case when products are ordered using the Internet or the telephone and then distributed from a single distribution point. In this example, data storage 16 might be two-dimensional rather than three-dimensional and might not reflect positions or members within the geography dimension. Furthermore, the data might be tracked by time, in which case data storage 16 might be two-dimensional and might not reflect positions or members within the time dimension. Other possible scenarios involving more or fewer than three dimensions will be apparent to those skilled in the art. For example, instead of or in addition to a geography dimension, data storage 16 may have a location dimension, a store dimension, or an outlet dimension used to organize the various physical locations where products might be sold. As further examples, data storage 16 might include a supplier dimension or a customer dimension. Data storage 16 may have any number of dimensions appropriate for the needs of the enterprise or facility associated with system 10.

In the three-dimensional example above, the values of the data measures within the set for a particular storage location 18 depend on the combined positions of members within product, geography, and time dimensions for that storage location 18. As a result, the values of the data measures typically vary with these combined

positions as appropriate to accurately reflect the sales, demand, available supply, selling price, or other data associated with these members. As described below, when a suitable combination of members is specified in the product, geography, and time dimensions according to operation of system 10, data storage 16 accesses the data measures for storage location 18 associated with that combination of members. Other suitable dimensions may replace or be combined with the product, geography, and time dimensions according to particular needs.

In one embodiment, data storage 16 supports multi-dimensional on-line analytical processing (OLAP) capability and is populated with data measures received from one or more transactional data sources that are internal, external, or both internal and external to the enterprise or facility associated with system 10. For example, and not by way of limitation, data measures received from sources internal to a manufacturing or warehousing facility may include unit shipping data, dollar shipping data, inventory data, pricing data, and any other suitable information. Data measures received from external sources, such as from syndicated partners of the enterprise or facility, may include point-of-sale demographic data and any other suitable information. Other data that may also or alternatively stored in data storage 16 includes planning data such as plans, forecasts, projections, or the like that are generated by system 10 or a user associated with system 10. Appropriate data measures may be stored in data storage 16 in any suitable manner.

System 10 may operate on one or more computers 20 that are integral to or separate from the hardware and/or software that support server 12, client 14, and data storage 16. Computer 20 may include a suitable input device 22, such as a keypad, mouse, touch screen, microphone, or other device to input information. An output device 24 may convey information associated with the operation of system 10, including digital or analog data, visual information, or audio information. Computer 20 may include fixed or removable storage media, such as magnetic computer disks, CD-ROM, or other suitable media to receive output from and provide input to system 10. Computer 20 may include one or more processors 26 and associated memory to execute instructions and manipulate information according to the operation of system 10. Although only a single computer 20 is shown, server 12, client 14, and data storage 16 may each operate on separate computers 20 or may operate on one or more

shared computers 20. Each of the one or more computers 20 may be a work station, personal computer (PC), network computer, personal digital assistant (PDA), wireless data port, or any other suitable computing device.

Server 12 is coupled to data storage 16 using link 32, which may be any wireline, wireless, or other link suitable to support data communications between server 12 and data storage 16 during operation of system 10. Data storage 16 may be integral to or separate from server 12, may operate on one or more computers 20, and may store any information suitable to support the operation of system 10. Server 12 is coupled to client 14 using link 30, which may be any wireline, wireless, or other link suitable to support communications between server 12, client 14, and the processes of server 12 and client 14 during operation of system 10. Although link 30 is shown as generally coupling server 12 to client 14, processes of server 12 may communicate directly with one or more corresponding processes of client 14.

FIGURE 2 illustrates an example product dimension 50 within data storage 16 that includes a hierarchy of product levels 52 each having one or more members 54. Although one example hierarchy is illustrated, it should be understood that a dimension may have multiple alternative hierarchies. The value of each data measure associated with a member 54 may be an aggregation of the values of corresponding data measures associated with hierarchically related members 54 in lower levels 52 of product dimension 50. In an example embodiment in which system 10 provides sales forecasts, the sales associated with a member 54 is the aggregate sales for these hierarchically related members 54 in lower levels 52 of product dimension 50. In the illustrated embodiment, product levels 52 for product dimension 50 include an all products level 58, a product type level 60, a product category level 62, and a product family level 64. Selected and merely example hierarchical relationships between members 54 are shown using links 56, as described more fully below. Links 56 between hierarchically related members 54 in adjacent levels 52 of product dimension 50 reflect parent-child relationships between members 54. Although FIGURE 2 is described primarily in connection with sales relationships, the following description is similarly applicable to other data relationships, such as demand, available supply, selling price, or any other relationships relating to data measures associated with an item or set of items. Furthermore, although described above, the value of measures at

aggregated levels may not always be a simple aggregation. A number of alternative aggregation techniques may be used including, but not limited to, averages, minima and maxima, and (in the time dimension) first and last (for example, the value for a month is the value of the first or last week in a month). Values of measures at aggregated levels may also be determined by applying a rule. For example, one example measure is "selling price." Such a measure generally cannot be generated at aggregated levels by any form of aggregation, but can only be generated by applying a rule (for example, (aggregated) sales dollars divided by (aggregated) sales units). Any other appropriate rules may similarly be used.

10 In the particular example shown in FIGURE 2, all products level 58 contains "All" member 54 representing the aggregate sales for all members 54 in lower levels 60, 62, and 64 of product dimension 50. Product type level 60 contains "Components," "Base Units," and "Options" members 54. "Components" member 54 represents the aggregate sales for hierarchically related members 54 below
15 "Components" member 54 in levels 62 and 64 of product dimension 50. Similarly, "Base Units" member 54 represents the aggregate sales for hierarchically related members 54 below "Base Units" member 54 and "Options" member 54 represents the aggregate sales for hierarchically related members 54 below "Options" member 54. Links 56 between "All" member 54 and "Components," "Base Units," and "Options"
20 members 54 indicate the hierarchical relationships between these members 54.

Product category level 62 contains, under "Components" member 54, "Hard Drives," "Memory Boards," and "CPUs" members 54. "Hard Drives" member 54 represents the aggregate sales for hierarchically related members 54 below "Hard Drives" member 54 in level 64 of product dimension 50. Similarly, "Memory
25 Boards" member 54 represents aggregate sales for hierarchically related members 54 below "Memory Boards" member 54 and "CPUs" member 54 represents the aggregate sales for hierarchically related members 54 below "CPUs" member 54. Links 56 between "Components" member 54 and "Hard Drives," "Memory Boards," and "CPUs" members 54 indicate the hierarchical relationships between these members
30 54. Analogous links 56 reflect hierarchical relationships between "Base Units" and "Options" members 54 of product type level 60 and corresponding members 54 in lower levels 62 and 64 within product dimension 50.

Product family level 64 contains, under "Hard Drives" member 54, "4GB" and "6GB" members 54. Links 56 between "Hard Drives" member 54 and "4GB" and "6GB" members 54 indicate hierarchical relationships between these members 54. Analogous links 56 reflect hierarchical relationships between "Memory Boards," "CPUs," "Servers," "Desktops," "Laptops," "Monitors," "Keyboards," and "Printers" members 54 of product category level 62 and corresponding members 54 in lower level 64 within product dimension 50. Although no links 56 are shown between members 54 in product family level 64 and possible lower levels 52, such further levels 52 may exist within product dimension 50 and analogous links 56 may exist to reflect the corresponding hierarchical relationships. Furthermore, members 54 shown in FIGURE 2 are example only and are not intended to be an exhaustive set of all possible members 54. Those skilled in the art will appreciate that other suitable members 54 and associated links 56 may exist.

FIGURE 3 illustrates an example geography dimension 70 within data storage 16 that includes a hierarchy of geography levels 72 each having one or more members 74. Although one example hierarchy is illustrated, it should be understood that a dimension may have multiple alternative hierarchies. The value of each data measure associated with a member 74 may be an aggregation of the values of corresponding data measures associated with hierarchically related members 74 in lower levels 72 of geography dimension 70 (although other aggregation techniques may be used, as described above). In the example embodiment in which system 10 provides sales forecasts, the sales associated with a member 74 is the aggregate sales for these hierarchically related members 74. In this embodiment, geography levels 72 for geography dimension 70 include a world level 78, a country level 80, a region level 82, and a district level 84. Selected and merely example hierarchical relationships between members 74 are shown using links 76, which are analogous to links 56 described above with reference to FIGURE 2. Although FIGURE 3 is described primarily in connection with sales relationships, the following description is similarly applicable to other data relationships, such as demand, available supply, selling price, or any other relationships relating to one or more data measures associated with an item or set of items.

In the particular example illustrated in FIGURE 3, world level 78 contains

"World" member 74 representing aggregate worldwide sales. Country level 80 contains "U.S." and "Canada" members 74, which represent aggregate sales for the United States and Canada, respectively. Link 76 between "U.S." members 74 in country level 80 and "World" members 74 in world level 78 indicates a hierarchical relationship between these members 74. Similarly, link 76 between "Canada" member 74 and "World" member 74 indicates a hierarchical relationship between these members 74. In this example, worldwide sales is an aggregation of aggregate sales in the United States as well as aggregate sales in Canada. Although other links 76 are not described in detail, those skilled in the art will appreciate that links 76 are analogous to links 56 described above with reference to FIGURE 2 in that each represents a corresponding hierarchical relationship between members 74 in the various levels 72 of geography dimension 70. As discussed above, geography dimension 70 may be eliminated or otherwise not considered in allocating data, for example, if geography dimension 70 is not relevant to particular data forecasting needs. Data storage 16 might in this situation be two-dimensional.

Sales or other forecasts may be derived using traditional forecasting techniques and suitable information concerning products, geographic areas, customers, and/or other data dimension. Such information may include historical sales, causal factors, key account input, market intelligence, and the like. Forecasting techniques may rely on hierarchical relationships between members 54, 74 to allocate data forecasts for products corresponding to members 54, 74. As described above, the data measures associated with each member 54, 74 are an aggregation of the data measures associated with some or all members 54, 74 in lower levels 52, 72 within the same hierarchy of parent-child links 56, 76. Therefore, given forecast data for a member 54, 74 (a parent) at one level 52, 72, the forecasts for each of the related members 54 in the next lowest level 52, 72 (the children of the parent) may be determined by disaggregating the forecast data for the parent between the children. Furthermore, although the terms "parent" and "children" are used above to identify a relationship between members 54, 74 of a single dimension 50, 70, these terms may also be used to refer to the relationship between data measures or values associated with a storage location 18 associated with a member from each of a number of dimensions. For example, a storage location 18 that includes a sales value for a

particular product in a particular state may be hierarchically related to a storage location 18 that includes a sales value for the product in a city of that state (the value associated with the former storage location 18 being a parent of the value associated with the latter storage location 18).

- 5 In addition to sales or other data forecasting, numerous other operations may be performed on the data in data storage 16 and data associated with particular members may be accessed for a variety of reasons. In many such cases, a user may desire or be required to select a subset of the members of a hierarchical dimension for use in a particular process (such as viewing planning data or allocating particular
- 10 data). As described above, the dimensions (such as dimensions 50 and 70) reflect actual structures in the organization. In many types of businesses, these structures can frequently change. When members of a hierarchical dimension are added or deleted, have their position in a hierarchy changed, or have other characteristics changed on a frequent basis, a "hard coded" set of members used to perform a particular business
- 15 process or function may quickly become out of date and have to be recreated. This process is time-consuming and inefficient and hampers the planning or other functions of a business.

- System 10 provides a technique for recording the selection of members that overcomes these problems. This technique, rather than recording the particular
- 20 members that are selected, remembers the sequence of events the user went through to determine the members that are selected. This sequence of events can then be repeated once the hierarchy is modified and produce a new selection of members that satisfies the user's original intent. The effective life of such member selection processes may be a significant length of time, spanning many cycles of changes or
- 25 reorganizations of the underlying hierarchical dimension. This significantly reduces the effort necessary to support a planning or other process that uses the selected members as input and also helps to ensure that the selection continues to be the members that satisfy the original intent of the user, even where there may be changed circumstances (including those of which the user is unaware). Without such a system,
- 30 the user may have to constantly recreate the member selections (thus wasting time that would be better employed in the business process) or risk that the wrong information will be used in the process due to the selection not being up to date.

System 10 (for example, using server 12 and/or client 14) may provide one or more user interfaces that implement a member selection process. Such an interface may display one or more hierarchies of members included in one or more dimension as a "tree-like object." Such tree-like objects are often used in applications such as

5 file directory viewers to illustrate the various hierarchical folders or directories included on a storage device. As with these folders or directories, members in a hierarchy may be selected and branches of the hierarchy may be expanded or collapsed using a user input device 22, such as a mouse. Furthermore, this user interface that can save a sequence of user inputs used to select particular members and

10 can "replay" these inputs to generate a new selection of members based upon the members and hierarchical relationships present when the inputs are replayed.

FIGURE 4 illustrates an example member selection interface 100 that may be provided by system 10. Member selection interface 100 provides a user with the ability to navigate through a hierarchy of members and select particular members the

15 user desires for a particular function. Interface 100 provides a dimension "drop-down" menu 102 or other dimension selection tool that allows a user to select a particular data dimension from which members are to be selected. For example, the user may select a product dimension, a geography dimension, a time dimension, or any other appropriate dimension. Interface 100 allows a user to select members from

20 one of the hierarchies that are valid in the current context and for the selected dimension. The current context is the portion of the data in data storage 16 to which the particular user has access or in which the particular user is interested. A hierarchy "drop-down" menu 104 or other hierarchy selection tool may be provided in interface 100 to allow the user to select a hierarchy associated with the selected dimension.

Furthermore, interface 100 includes a level selection table 106 that identifies

25 each of the levels included in the selected hierarchy. The name of each level in the hierarchy is displayed along with a level selection box 108 or other selection tool that allows the user to indicate the selection of one or more levels in the hierarchy. The level selection dictates what levels are shown in a member selection tree 110 that is

30 also included in interface 100. Member selection tree 110 may hierarchically display the members included in one or more of the levels selected in table 106. Interface 100

may include a button 112 that the user may select to apply the selection of levels in table 106 to tree 110.

Tree 110, like many file navigation tools, allows a user to navigate through the nodes of the tree (in this case, the members of the hierarchy) and to collapse and expand members in tree 110. The user may select a particular member and collapse or expand the portion of the hierarchy below the selected member. For example, clicking on a "+" next to a member may expand the tree below the member and clicking on a "-" next to a member may collapse the tree below the member. Interface 100 may also provide an option that, when selected by the user, fully expands every descendant of a selected member. As described below, the user may select one or more of the members in tree 110 to be used in performing a particular function. The members that are selected may form a "member query" that may be communicated to an appropriate destination (such as server 12) to identify the members that are relevant to the particular function. Interface 100 may provide a name edit box 114 that displays the name of the member query currently being created (through the selection of members in tree 110) to allow the user to subsequently retrieve the query for reuse.

Each member in tree 110 may have associated flags (such as Boolean state flags). One first such flag may be a selection flag that indicates whether the associated member has been selected by the user. Another flag may indicate whether the member has been expanded or collapsed. It should be noted that a child may be expanded even if its parent is collapsed.

There are three core actions that a user may perform on tree 110. The first such action is selecting or deselecting a member. As an example, a user may click or double-click on a member to select or deselect the member. In particular embodiments, if the member is expanded (the children of the member are shown in tree 110), this action will only select or deselect the member itself. If the member is collapsed, this action will select or deselect the member and all descendants of the member. The second action that the user may perform is expanding or collapsing a member. This action sets the state of a member as to whether its direct children should or should not be displayed in the tree.

The third action that the user may perform using tree 110 is to accept the members that have been selected and use these members to form a member query. For example, a user may select a "Get Data" button 116 or other appropriate button to accept a particular selection of members. In particular embodiments when the user
5 accepts the current selection, all members that are both visible and selected are included in the member query. System 10 can determine whether a member is visible in the tree based on the collapsed/expanded flags. A member is visible if all its ancestors have the expanded flag set.

As described above, it is desirable to record a selection of members for later
10 use. However, simply recording a "snapshot" of the selected members in the current hierarchy tree has the problem of recreating the desired member selections when the underlying hierarchical structures change. For example, if a class is moved from department to department (thus moving a member) or if a new store is added in a particular region (thus adding a member), then the tree must automatically reflect the
15 new structures when it is next loaded. The approach implemented in system 10 addresses these problems by recording the sequence of actions that the user took to select particular members and persists these actions instead of the actual tree. The sequence of actions may then be replayed to generate a desirable member selection.

The member selections may be persisted by creating a member selection script
20 that may be used to record and reproduce the actions taken by a user in interface 100. The term "script" as used herein should be understood to include all appropriate formats and techniques for recording user actions so as to allow the actions to be reproduced upon execution of the "script." Such a script may include a sequence of commands and associated parameters. Although example commands and parameters
25 are described below, it should be understood that the following script concepts may be implemented in any appropriate manner using any suitable format. For example, an XML format may be used as an alternative to the example format described below.

One command that may be used in a member selection script is a hierarchy selection (or *HIERSELECT*) command. An example of such a command is as
30 follows:

HIERSELECT: hiercode [MODE= FRESH|SWITCH|MULTI]

The *HIERSELECT* command changes the hierarchy on which subsequent script commands operate. A *HIERSELECT* command may be added to a member selection script when a user selects a hierarchy using hierarchy “drop-down” menu 104 or other
5 hierarchy selection tool of interface 100.

A script may operate concurrently on multiple hierarchies. In such cases, system 10 maintains a selection tree 110 for each of the hierarchies that have been selected. In the example *HIERSELECT* command, a *hiercode* parameter may be used to specify the code of the hierarchy (alternatively, a hierarchy name may be
10 specified). The *MODE* parameter determines how multiple hierarchies are dealt with. If *MODE=FRESH* is specified (which may be the default), the new hierarchy that is specified in the command is selected and all previous members selections are not considered. If *MODE=SWITCH* is specified, the new hierarchy that is specified in
15 the command is selected and all previous members selections in any previous hierarchies are not considered, but the member selections in the previous selections are applied to the new hierarchy. If the members are not valid in the new hierarchy then their selection is ignored. If *MODE=MULTI* is specified, then all member
20 selections in any previous hierarchies are retained.

In addition to providing commands to select hierarchies, the member selection
20 script also provides the ability to designate the selection of particular levels in the selected hierarchy. The script may use a *level_id* parameter to provide the ability to designate a level included in the selection hierarchy. An example syntax of the *level_id* parameter is as follows:

25 *level_id: levelcode | TOP [+n] | BOTTOM [+n]*

A level may be specified using the *level_id* parameter in a number of different ways. For example, a *levelcode* may be used to identify a level using a level code generated by system 10 or specified by a user. A level may also be identified using the *TOP*
30 parameter, which identifies the highest level in tree 110. A numeric parameter may be supplied with the *TOP* parameter to identify a level that is *n* levels down from the highest level. Alternatively, a level may be identified using the *BOTTOM* parameter,

which identifies the lowest level in tree 110. A numeric parameter may be supplied with the *BOTTOM* parameter to identify a level that is *n* levels up from the lowest level.

It should be noted that one advantage of providing relative selection of levels (for example, *TOP +2*) arises when the context in which the query is subsequently deployed is different than the context in which it was defined. For example, when the query is defined, the levels in an example hierarchy may be company, division, department, and class; however, when the query is subsequently used the levels may have been modified to just division, department, class (for example, because a smaller “segment” of the plan was loaded). If the user wants the member selection or other action to occur at the “division” level, the user can use the explicit selection of the level, such that a change in the hierarchy will not affect this action. However, if the users wants the action to always apply to the level below the top level (“division” in the first context, but “department” in the second context), the user can use the relative form of selecting the level.

A level may be selected using a *LEVELSELECT* command in combination with a specified *level_id* as follows:

LEVELSELECT: level_id

20

A *LEVELSELECT* command may be included in a member selection script when a user uses a level selection box 108 or other selection tool of interface 100 to select a level. Each of the levels that are defined in the active hierarchy within the current context are available for selection. Selecting or de-selecting a level affects the way that expansion of a member within tree 110 is treated. If a level is not selected, then the members at that level are omitted from tree 110 when their parent is expanded. The descendant members at the next lowest selected level will be added to tree 110 (assuming it is selected). The selected levels also determine to which levels the members are expanded when executing the *MEMBEREXPAND* command, which is described below. If a level was previously selected then the level remains selected upon its reselection using this command.

A level may be deselected using the following command:

LEVELDESELECT: level_id

Any members previously selected at the level being deselected will become
5 deselected. A *LEVELDESELECT* command may be included in a member selection
script when a user uses a level selection box 108 or other selection tool of interface
100 to deselect a level.

A level may also be selected or deselected based on the previous state of the
level as follows:

10

LEVELTOGGLE: level_id

This command selects a level if it was previously deselected and deselects a level if it
was previously selected.

15

As described above, a user may also expand one or more members to view the
children of a member. Such a member expansion may be performed by and recorded
using the following command:

MEMBEREXPAND: membercode [DEPTH=CHILDREN| numeric| BOTTOM]

20

This command marks (for example, using a flag) a member as being expanded. The
DEPTH parameter defines how far down in the hierarchy to expand to. This
parameter may only operate on the active levels. *DEPTH=CHILDREN* may be the
default and should expand the member to the next level down. *DEPTH=numeric*
25 defines how many levels down the hierarchy to expand to. For example, if *DEPTH=2*
is specified, it means expand the member to show its children and its grandchildren.
DEPTH=BOTTOM means expand to the lowest level in the hierarchy. Again, this
parameter may only apply to the active levels defined by prior *LEVELSELECT*
commands.

30

In a similar manner, members may be collapsed using the following
command:

MEMBERCOLLAPSE: membercode

If children members of a member to be collapsed were previously expanded, then their expanded state should be retained.

- 5 When the user has selected a hierarchy, selected appropriate levels in the hierarchy, and/or expanded or collapsed particular members of the selected hierarchy, the user may select one or more members (although the user may select members before, after, or without performing any of these other actions). The selection of a member may be performed by and recorded using the following command:

10

MEMBERSELECT: membercode

- 15 A *MEMBERSELECT* command may be added to a member selection script when a user selects a member by clicking on the member or its parent in tree 110 (or otherwise selecting the member). If the member is collapsed, this command marks as selected all of the member's descendents in the tree (note that the descendent members may expanded even though the parent is collapsed). If a selected member is expanded, then there is no change to the selection state of its descendents.

A similar command may be used to deselect a member:

20

MEMBERDESELECT: membercode

- 25 If the specified member was previously de-selected, then it should remain de-selected. If the member is collapsed, the member and all its descendents in the tree are marked as deselected (note that the descendent members may expanded even though the parent is collapsed). If the member is expanded, then there is no change to the selection state of the descendents.

Another command may be used to toggle the selection state of a member as follows:

30

MEMBERTOGGLE: membercode

This command switches a member as being either selected or deselected depending on the previous selection state of the member. The functionality is equivalent to the *MEMBERSELECT* and *MEMBERDESELECT* commands.

The following is a sample script that may be created based on a user's actions in interface 100 (alternatively, the user may manually create the script in whole or in part):

HIERSELECT: STANDARD

LEVELDESELECT: SUB-CLASS

10 *MEMBERSELECT: D1*

MEMBEREXPAND: D1

MEMBERDESELECT: C2

MEMBEREXPAND: C1

MEMBERDESELECT: S1

15

FIGURE 5 illustrates an example hierarchy 200 upon which this example member selection script operates (the "standard" hierarchy specified in the script). Hierarchy 200 includes four levels: department level 202, class level 204, sub-class level 206, and style level 208. As an example only, these may be levels in a standard hierarchy of a product dimension associated with clothing product data. Department level 202 has one member: D1. Class level 204 has two members: C1 and C2. Sub-class level 206 has three members: SC1, SC2, and SC3. Style level 208 has seven members: S1, S2, S3, S4, S5, S6, and S7. The hierarchical relationships of these various member are illustrated in FIGURE 5.

25 Upon execution of the above script, the following members will be selected (and are indicated by hatching in FIGURE 5): D1, C1, S2, S3, and S4. The script causes the following actions to be taken to reach this set of selected members (and these actions may reflect previous user actions in interface 100 that were recorded in the example script above). First, the illustrated hierarchy is selected. Sub-class level 30 206 is then deselected so that it is not included in tree 110 of interface 100 (the other levels are selected by default). Next, member D1 is selected. Since D1 was not previously expanded, all of the descendants of D1 are also automatically selected

(except those members in sub-class level 206, which was deselected). D1 is then expanded such that its children, C1 and C2 are shown in tree 110. Next, C2 is deselected. Since C2 is collapsed, deselecting C2 also deselects its descendants that were already selected (in this example, S5, S6, and S7 – SC3 was never selected since level 206 was deselected). C1 is then expanded to show the descendants at the next selected level, S1, S2, S3, and S4. S1 is then deselected, leaving D1, C1, S2, S3, and S4 as the selected members of hierarchy 200.

Based on an understanding of how a message selection script is created, a user may choose a way of selecting particular members that will produce a desirable member selection even when it is executed after the relevant hierarchy has been modified. The example script represents one technique by which a user may select particular members of style level 208 (as well as other members) through a sequence of actions by the user. This sequence affects what members are selected if the members included in style level 208 changed. For example, if another child of member SC1 were added to level 208, this child would end up being selected using example script (since the user had to explicitly deselect S1 given the previous actions the user had taken). However, the same member selection could have been generated using a different sequence of actions. For instance, if D1 was expanded before being selected, then no members in level 208 would have been selected through the selection of D1. Afterwards, the user could have expanded C1 and selected particular grandchildren of C1 (for example, S2, S3, and S4, but not S1). In this case, if a new child was later added under SC1, this child would not be selected when the user's actions are reproduced using a member selection script (unlike if the example script above was used). Therefore, the user is able to control the affect of changes in a hierarchy on the members of the hierarchy that are selected based on the user's actions that have been recorded in a script.

FIGURE 6 illustrates an example method for creating and reproducing member selections. The method begins at step 300 where system 10 communicates a member selection interface 100 to a user. As described above, member selection interface 100 may include numerous tools allowing the user to take various actions associated with the selection of members in a hierarchy. Member selection interface 100 may be communicated to the user using any suitable technique. As an example,

member selection interface 100 may be displayed to the user as a web page or pages and communicated to the user as an HTML file, an XML file, an applet, a script, or any other appropriate mechanism for generating web pages. The user may provide input by using the web page and an associated web browser to communicate with a web server or other appropriate component. Alternatively, member selection interface 100 may have any other appropriate format and information may be communicated to and received from the user using any suitable technique. For example, member selection interface 100 may be a desktop user interface provided by an application executing locally on a computer.

At step 320, system 10 receives from the user a selection of a dimension from which members are to be selected. System 10 may also receive a selection of a hierarchy of the selected dimension from the user at step 304. At step 306, system 10 may further receive an indication from the user of one or more levels of the hierarchy that are to be displayed to the user when selecting members of the hierarchy. This indication may be the express selection or deselection of particular levels in the hierarchy (and the default may be that all levels are selected). Based on these selections (although some or all of these selection steps may not be performed by the user and are not required), system 10 communicates a member selection tree 110 to the user at step 308. Member selection tree 110 may be displayed to the user in member selection interface 100, as described above. Member selection tree 110 displays the members included in the selected levels in the selected hierarchy of the selected dimension.

At step 310, system 10 receives requests from the user to perform various actions on member selection tree 110 associated with the selection of one or more members. As described above, these actions may include the expansion, collapsing, selection and/or deselection of one or more of the members in tree 110. Furthermore, as described above, these requests are received in a particular sequence that affects which members are eventually selected. System 10 records some or all of the user input described above in a member selection script at step 312. This user input may include the selection of one or more dimensions, hierarchies, and/or levels, as well as the expansion, collapsing, selection, and/or deselection of one or more members. The

user input may be recorded in a script as it is received or the input may be temporarily stored and then recorded after the user has finished with the member selection.

As described above, the user's action may be reproduced at a later time to create a member selection. This is true even if the relevant member hierarchy has changed. At step 314, system 10 receives a request from a user, a component of
5 system 10, or any other appropriate source to reproduce a user's previous member selections using a script. System 10 executes the script at step 316 to reproduce the recorded users actions and to generate a set of selected members from a hierarchy, and the method ends. The script may be executed as many times as desired to
10 reproduce the recorded actions.

As an alternative to member selection interface 100, the user may manually create a script. For example, the user may determine the sequence of actions that should be performed to select one or more members and the user may then "program" these action into script. For example, the user may use a word processor or other
15 appropriate tool to generate the script using the commands described above or other appropriate commands (and the script may be compiled or otherwise manipulated to make it executable, if necessary). Furthermore, a user may modify a script that was automatically or manually generated.

Although the present invention has been described with several embodiments,
20 numerous changes, substitutions, variations, alterations, and modifications may be suggested to one skilled in the art, and it is intended that the invention encompass all such changes, substitutions, variations, alterations, and modifications as fall within the spirit and scope of the appended claims.